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the Bureau, it is impossible to establish the effect of this difference, but the presumption is strongly in favor of a weighted index number of clothing.

As has already been noted, the group of expenditures which is called sundries by the Board is divided by the Bureau into two groups known respectively as miscellaneous and furniture and furnishings. The index number for sundries is made by the Board from prices of "car fare, doctor's fees, church contributions, organization dues, insurance, reading, amusements, candy, soft drinks, tobacco, furniture and furnishings, and household supplies." But only rough estimates of changes in the prices of these articles are made, and the weight assigned to each of these articles or groups of articles is not stated. The Bureau of Labor Statistics does not publish the list of articles included in the miscellaneous and furniture and furnishings groups, nor the system of weights employed. Even conjecture as to the cause of the disagreement is, therefore, impossible.

In what has been said above, attention has been directed to the disagreement of the two index numbers. From a wider point of view, their correspondence is more important. For many years the question of devising a more adequate measure of the cost of living than the index number of retail food prices has been discussed, and the opinion has frequently been expressed that the difficulties to be faced were insuperable. When differences in material and method are taken into account, the substantial correspondence of the two index numbers here compared is the best proof that such a measure is practicable. Neither the index number of the Board nor that of the Bureau is the last word in measures of the cost of living, but they possess the great merit of having demonstrated the practicability of such measures. The index number of the Board has contributed materially to establishing the influence of measures of change in the cost of living in wage determinations. The more frequent appearance of the Board's index number has facilitated the use of such measures of change, and its general correspondence with the index number of the Bureau has greatly enhanced the prestige of such measures. The Board has done a useful piece of work and it is to be hoped that the maintenance of an index number of the cost of living will be a permanent part of its work.

ON THE BEST FORM OF INDEX NUMBER

By Royal Meeker, *International Labor Office, Geneva*

There is undoubtedly at the present time a keener interest in price fluctuations and a better understanding of index numbers as a measure of such fluctuations than ever before. The importance of measuring price changes accurately and promptly makes the consideration of the methods employed in constructing index numbers especially timely. It is a matter of keen regret to me that distance and the duties of my new office made it impossible for me to attend the eighty-second annual meeting of the American Statistical Association, and to hear Professor Irving Fisher's views on the best form of index number and the illuminating discussion which followed. It is not clear from the brief summary of Professor Fisher's paper published in the March issue of the QUARTERLY whether he considers the mathematical formula for computing an index number of equal, greater, or less importance than the other characteristics of index numbers which he mentions. My own experience in recalculating the wholesale and retail price indices of the United States Bureau of Labor Statistics convinced me that the particular mathematical formula to be used in computing index numbers, while not a trifling matter, is of minor importance compared with the commodities to be selected for inclusion in the index, their prices and their quantities to be used as weights. Although the range of my experimentation was rather limited, it did not seem to me that it made much difference what machinery of calculation was used as long as the raw materials from which the index numbers are made is of good, sound, dependable quality. To borrow from Professor Fisher's picturesque and forcefully descriptive vocabulary, "it matters but little what mathematical formula we use in computing the indices of *p*'s and *q*'s as long as we mind our *p*'s and *q*'s." If Professor Fisher or any one else had convinced me in 1914 of the superiority of the geometric mean over the weighted arithmetic mean or "price aggregate" method of computing index numbers of wholesale prices, I would cheerfully have discarded the arithmetic mean and adopted the geometric mean. I would have done so notwithstanding the fact that a "price aggregate" is easily comprehensible by any one of ordinary intelligence as the cost of a given bill of goods, whereas the geometric mean is understandable only by those who have a pretty clear comprehension of mathematics.

I am quite puzzled by the rather bizarre mathematical formula employed by Professor Fisher to illustrate the defects of the weighted arithmetic mean. Certainly no one advocates using such a double system of weighting today. The compilers of the old index numbers published by the British Board of Trade made use of weighted price relatives, but these price relatives were weighted by constants representing the estimated money values of each commodity in the base year or period. The mathematical method employed in computing the old Board of Trade index numbers was sound enough. The defects in these indices were to be found in just those things which are left out of Professor Fisher's discussion, viz., the character and number of the commodities included, the sources of the "prices," and the quantities used as weights. I do not wish to be understood as undervaluing mathematical precision in calculating index numbers, but I feel sure that even the absurd double weighted mathematical formula given in the illustration by Professor Fisher could be applied to any series of index numbers which includes all important representative commodities without very much changing them. My experience in recalculating the Bureau of Labor index numbers of wholesale prices convinces me that this would prove to be the case. What could be more absurd than the wildly erratic weightings contained in the so-called "unweighted" index number, in which the prices of nutmegs, pig iron, wheat, 1-inch augurs, cotton, quinine, potatoes, chisels, and pork all had equal influence upon the general level of prices? Certainly it was natural that I should feel qualms of misgiving during the process of transforming the old "unweighted" index numbers into the new "weighted" ones, especially as I was obliged to do some most heroic "estimating" in arriving at some of the quantity weights to be used. I shall deal with the problems of quantity weights later. Yet the discrepancies between the old Bureau of Labor index and the new are not very great, not nearly so great as I expected. Professor Mitchell, who advised and assisted me throughout in the recalculation, was also astonished, I think, that greater differences were not shown. In fact the differences were so slight that I was led to remark that no matter what the statistician does with an index number, he is always bound to come out right. This seems scarcely an exaggeration as long as the index contains all the important representative commodities and the statistician is honest and does not purposely try to make the index "point a moral or adorn a tale."

It seems to me that Professor Fisher is trying to perform a miracle, or at least to accomplish the impossible. Indices, like all human devices, are strictly limited in their uses and applications. While I was commissioner of labor statistics, I received communications beseeching me, as official price compiler and controller, to use my authority to bring prices down. Some persons apparently thought that prices were rising because the index numbers were increasing, and that all that was necessary to bring down prices was to decrease the index number. How very fortunate for the compilers of index numbers that prices cannot be controlled by index numbers! It is, perhaps, not so fortunate that index numbers are so limited in their usefulness. A price index number can never show anything but variations in prices, and even that only imperfectly. I suppose Professor Fisher's statement that index numbers are "precise within much less than 1 per cent" refers to the precision of the mathematical computations. I think the raw materials from which price indices are made contain much more than 1 per cent of impurities. A price index cannot be made to show variations in the quantities of commodities produced, exchanged, or consumed. Nor can an index number of quantities be made to show variations in prices. Yet, if I understand Professor Fisher, he would perform the miracle of showing by one and the same index variations in production (or exchange or consumption) and variations in prices. It does not seem to me that he has met Professor Persons' criticism. I do not doubt for a moment that Professor Fisher's formula will stand on its head and do all the other things he says it will do. I am not at all certain, however, that an index number that can stand on its head is to be preferred above all other indices on that account. Professor Fisher's formula would give us the square root of the product of an index number, say for 1920, calculated by the price aggregate method on the quantities of goods purchased in 1920 multiplied into a price index for 1920 calculated by the same method on the quantities of goods purchased, say in 1915. We have here an inextricable mixture of changes in prices and changes in quantities of goods. What does this "ideal index," which has been achieved by so much mathematical labor, represent? Is it an index of price changes? Or is it an index of quantity changes? The answer seems clear that it is both and neither. The perfect reversibility of the index number does not seem to me to be of any consequence at all. The all important fact is that this number does not mean anything that can be clearly grasped. Judging by my experience with index numbers, it seems to me more than likely that the quantity obtained by Professor Fisher's formula would differ but slightly from year to year, or even over five or ten year periods, from a price index computed by the formula I used for calculating the present wholesale price index of the Bureau of Labor Statistics. This fact, if it be a fact, is also of little consequence, for even if the index computed by Professor Fisher's formula differed from the Bureau's index as widely as the East from the West, the former index would still be as imcomprehensible as ever.

It is a source of some satisfaction to me to note that Mr. Walsh, at the close of his discussion, advises for practical purposes the computation of index numbers by the same mathematical formula used by me in calculating the present weighted index numbers of the Bureau of Labor Statistics. The source of my satisfaction comes not so much from the agreement upon the formula as from the fact that Mr. Walsh realizes the practical difficulty of securing acceptable quantity weights, at least for past years. It seems to me that the perfect reversibility and the double weighting by the quantities in the base year and in the year for which the index is calculated, upon which Professor Fisher lays so much stress, are of no value at all; they may even constitute positive demerits. To insist upon these characteristics for the best index number is even more irrelevant than to insist that the best watch dog must be able to walk on his hind legs. Walking on his hind legs has nothing to do with his watchfulness, and therefore it need not detract from the dog's usefulness as a watch dog; but the double weighting proposed by Professor Fisher does affect the usefulness of the index as a measure of changes in either prices or quantities of goods.

I assume that Professor Fisher desires to have the price statisticians obtain the quantities of commodities each year. This would be impracticable or even impossible. Reliable estimates of quantities can be obtained for the basic raw materials and semi-manufactured goods each year; but for manufactured commodities, clothing, metals, manufactures, most building materials, and house-furnishing goods, the figures are not very accurate even in the census years, and it would be very difficult if not impossible to obtain trustworthy figures each year. It may be argued that very rough estimates of quantities are sufficiently accurate for weighting purposes and that the guesses and estimates from manufacturers and jobbers would be satisfactory. If this be true, it is an argument against going through the toil, trouble, and expense of gathering this very imperfect information and using it in the computation of index numbers by any formula. If quantity weights are to be used the quantities should be approximately accurate. To be sure, under the impulse of war-time patriotic fervor and strong pressure from the government, business firms did report their production quite accurately to the War Industries Board. But a War Industries Board with all its cumbersome and expensive machinery could not be maintained in time of peace. I see no hope of getting each year quantity weights of sufficient accuracy to make it worth while to use them in Professor Fisher's formula. Even if satisfactory quantities could be obtained, the labor of performing the required mathematical computations would be so considerable that I scarcely think public statistical offices would undertake it.

Mr. Flux, the compiler of the new wholesale index number of the British Board of Trade, regards accuracy in the quantity weights as of minor importance in an index computed by the method of the geometric mean. He therefore used as weights rough estimates of the value of goods produced and imported into the United Kingdom as shown in the census of production of 1907, the latest figures available. Mr. Flux expressed the opinion, however, that accuracy in weights is essential in an index computed by the method of the arithmetic mean, which is the method used in computing the United States Bureau of Labor Statistics index and which is recommended by Professor Fisher for the proposed index in all calculations up to the final one. It would surely seem that if quantity weights are to be used at all they should be as accurate as possible. I therefore think it would be quite sufficient to revise the quantity weights every ten years, as soon as the decennial census figures become available.

Even more important than accuracy in the quantity weights are accuracy and representativeness in the price quotations. The prices used by the Bureau of Labor Statistics may be criticised on the ground that they are not homogeneous since they are obtained from different sources. Of 371 quotations in 1919, 203 are obtained from trade journals, 152 from manufacturers or sales agents, 13 from boards of trade, and 3 from federal or state bureaus. While commissioner of labor statistics, I tried to secure all quotations direct from jobbers and wholesalers, but with the slender resources of the Bureau it was impossible to discontinue the use of the trade journals. All prices were thoroughly checked and revised, however, and it can be said with confidence that they are the best obtainable unless much more money is to be spent than has ever been spent on wholesale prices by the Bureau. It may be worth stating, in view of the charges of extravagance in government expenditures, that only two employees working only part of the time on wholesale prices have kept this work up to date, so that the indices for the nine groups of commodities and for all commodities are issued to the press, and to all who desire them, each month for the preceding month. It is very desirable that more money should be spent in securing absolutely trustworthy *wholesale* prices as distinct from either *manufacturers'* prices or *trade journal* prices. The Federal Trade Commission, the Federal Reserve Board, or some other federal agency should take over the task of gathering these price statistics. It is important that *manufacturers'* or *producers'* prices should be gathered as well as *wholesale* prices and that index numbers be computed for both series of prices.

The wholesale prices of the Bureau of Labor Statistics are open to criticism in that too many quotations are secured from the big cities. Of 32 quotations of farm products, 19 are obtained from Chicago; of 100 food products, 26 are from Chicago and 42 from New York; of 21 fuel and light, 9 are from New York; of 43 metals and metal products, 20 are from New York and 12 from Pittsburgh; of 32 lumber and building material, 23 are from New York; of 18 chemicals, all are from New York; of 23 miscellaneous, 12 are from New York; of a total of 371 quotations, 56 are from Chicago and 132 from New York. Of course New York and Chicago are the largest markets in the country, and the trade journals and selling agencies are concentrated in these great centers; but it is obvious that prices to be representative should be scattered more widely. This means expending more money than Congress appropriates to the Bureau of Labor Statistics.

In my view the best way to achieve the "best index number" is first, to secure more trustworthy and more representative prices from (1) *producers* and (2) *jobbers* and *wholesalers*, and secondly, to obtain more accurate statistics and estimates of quantities of goods produced, imported, exported, and consumed. It is especially necessary that the estimates made by me in 1914 of the quantities of goods of various kinds entering into *exchange* be carefully checked and revised in the light of more recent and more detailed information. It is desirable that several different kinds of index numbers be prepared by the federal agency having in charge the collection of producers', jobbers', and wholesalers' prices and the compilation therefrom of price indexes. Much more time and effort should be devoted to the subject of producers' and wholesale prices than has been devoted to them in the past. When the quantities and the prices are thoroughly satisfactory I think it will make but little difference what mathematical formula is used in calculating the index numbers.

THE BUSINESS INDICES OF THE *FRANKFURTER ZEITUNG*

It has long since been the policy of the *Frankfurter Zeitung* to publish original statistics with regard to economic conditions in Germany. These statistics are of particular interest at the present time because of the chaotic condition of the German credit and currency situation.

The most interesting of the statistical series which are now compiled and published by this journal are its index numbers on wholesale commodity prices, securities' prices, wages per hour in Frankfurt, and foreign exchange values, its compilations of bankruptcies, and its compilation of securities issued in Germany. All these statistics appear in the current numbers of the paper. The index of securities prices is published weekly; the wholesale price index and the statement of securities issued appear at the first of each month; the bankruptcy figures are published quarterly, while the figures on wages have appeared only once (in the second edition of May 22, 1921), and the foreign exchange figures only once (on February 26, 1921). The index numbers among these series have also been published from time to time within the last six months in pamphlet form called, in its first edition, "Die Indexziffern der Frankfurter Zeitung," and thereafter "Die